

2.5 Human Factors and Aviation Medicine Program Area Description

Mission

The Human Factors and Aviation Medicine Program relies upon:

- *Applied research*
 - To identify methods that can contribute to the goal of reducing the fatal accident rate by 80%;
 - To develop enhanced guidelines for protective equipment and procedures; and
 - To provide recommendations for FAA regulatory and medical certification personnel to enhance safety of aircraft crewmembers and aircraft cabin occupants.
- *Innovative research and management initiatives*
 - To ensure that human factors policies, processes, and best practices are integrated in the research and acquisition of 100 percent of FAA aviation systems and applications.

The rapid evolution toward increased operational demand, diversity of aircraft and systems, changing technology, and globalization of the airline/aircraft industry challenges the Human Factors and Aviation Medicine Offices to meet these goals by:

- Ensuring that research is focused on those areas directly impacting aviation safety.
- Forming partnerships with research and university laboratories.
- Capitalizing on opportunities to leverage government and industry resources in order to rapidly transfer the results of research to the aviation community.
- Undertaking major efforts to ensure that human factors expertise is represented across functional disciplines and that human factors considerations are addressed throughout the FAA acquisition process.

Intended Outcomes

Human Factors research is increasing the safety and efficiency of the National Airspace System (NAS) by developing scientifically validated information and guidance for improving the perfor-

mance and productivity of air carrier crews, general aviation pilots, aviation maintenance and inspection personnel, air traffic controllers, and NAS system maintenance specialists. This program directly responds to FAA Strategic Plan goals to “eliminate accidents and incidents caused by human error” and to “implement new decision support systems and associated functional improvements that fully account for the proper role of people in the system.” Human Factors research is also initiated in support of the FAA goal to “reduce the costs of flying by making the air traffic management system more efficient to use.”

Human Factors research supports the development of human-centered flight controls and displays, and identifies aircrew training innovations that enhance safety and reduce performance inefficiencies. This research is increasing consideration of human factors in aircrew training. This research also explores prospects for safety enhancement through automated analysis of flight-recorded data and through application of human factors in certification of new aircraft and equipment design and modification.

In aviation maintenance, human factors research develops more effective methods for maintenance technician and inspector training, and improves aviation maintenance technician and inspector task performance. Aviation maintenance human factors research efforts are exploring the application of human factors interventions to improve aviation inspection performance, evaluating the effects of Maintenance Resource Management, and examining human error risk analyses in aviation maintenance and flightline operations. Research is also producing programs used for improving aviation maintenance and inspector team communication to prevent shift change communication errors.

In general aviation, safety is enhanced through the application of human-centered principles to the development of advanced displays and controls and to procedures that improve pilot decision making and performance.

In air traffic control, human factors research will provide design guidance and findings and recommendations from assessments of human perfor-

mance to guide the development of human-centered automation and procedures that will enhance controller decision making and reduce error-prone conditions. These efforts will also guide the development of tools and procedures to support Collaborative Decision Making in Air Traffic Management required for the future NAS to meet increased demand. An improved approach to classifying the human factors associated with operational errors/incidents will result in improved investigation techniques leading to recommendations such as in procedures and training for decreasing the frequency of those events.

Aviation Medicine research improves the health, safety, and survivability of aircraft passengers and aircrews through its identification of human failure modes and development of formal recommendations for counteracting human failure conditions. Through this research, the FAA develops bioaeronautical guidelines, standards, and models for aircraft cabin equipment, procedures, and environments as a basis for regulatory action to enhance appropriate human performance. New medical criteria, standards, and assessment/certification procedures are also developed to ensure full performance capability. By assessing flight attendant and passenger behavior and disease issues, guidelines will be proposed for actions to improve the health and safety of cabin occupants.

Program Area Outputs

The Human Factors research program:

- Identifies operational needs and problems involving human performance.
- Funds and guides research projects to address operational priorities.
- Forms partnerships with industry and academia.
- Elicits participation by the nation's top scientists and professionals.
- Provides Human Factors guidance to the FAA for development and implementation of new technologies, training and procedures.
- Facilitates transfer of research products to the operational community.
- The Aviation Medicine research program:
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- Produces data and other forms of information which support notices and regulations applicable to aircraft occupant health and safety.
- Develops output options in response to a public demand (e.g., better restraints for children in aircraft settings).
- Assesses disease transfer and other aircraft occupant health factors.

The FAA is concerned with ensuring the safety and efficiency of NAS operations, a critical element of which is operator performance. Through guidelines, handbooks, advisory circulars, rules, and regulations, the agency provides industry with human performance information and guidance critical to the design, operation, regulation, and certification of equipment, training, and procedures. The human factors program does the research that provides the technical information needed to generate these products and services.

Automation has been cited as a contributing factor in aircraft accidents (e.g., Cali AA965). Human factors research is examining flight deck automation design, operation, use and training, and has developed a prioritized research agenda of issues to be addressed. Air carrier training initiatives such as the Model Advanced Qualification Program (air carrier pilot training program which integrates both technical and crew resource management performance requirements) will allow air carriers to develop and utilize proficiency-based training that addresses issues related to automated systems. The Automated Performance Measuring System will provide airlines the ability to analyze routine operations for dangerous trends and tendencies. It also will provide insight into the details of daily carrier line operations, uncovering automation usage problems that occur while operating in a complex environment.

Validated pre-hire assessments for air traffic controllers, electronics technicians, and transportation system specialists will enable the FAA to select persons with appropriate knowledge, skills, and abilities for each occupation, thus reducing training required after employment as well as attrition due to poor person-job fit. Human factors assessments will be conducted to evaluate safety and efficiency gains associated with automated decision aids in air traffic control.

Scientists from the Office of Aviation Medicine and the National Institute for Occupational Safety and Health are examining cabin environmental quality issues and their effect on passengers and flight crews. Aviation Medicine is also developing bioengineering criteria to support aircraft seat and restraint system certification, human performance and ergonomic data to support emergency evacuation regulations and standards, biomedical criteria to support protective breathing equipment and operational procedures certification, and biochemical and toxicological criteria supporting the use or certification of aircraft interior fire, smoke, and toxicity limits.

Protecting humans in decelerative environments, existing radiation environments, protective breathing equipment, cabin evacuation, and water survival are investigated in the human protection and survival initiative. Toxicological assessment and sudden or subtle pilot incapacitation are key features of the accident investigation initiative. A program to survey the nature of in-flight medical emergencies, particularly the effectiveness of defibrillators carried on airlines, new vision corrective methods for aviation personnel, aircraft cabin environmental hazards, air ambulance medical requirements, and development of protocols for safe use of lasers in laser light shows to prevent incapacitation of pilots, represent current investigations under the aviation medicine program support initiative.

Program Area Structure

The human factors program addresses operational requirements through research in the following five technical thrust areas as agreed to by the FAA, NASA, and DOD in the *National Plan for Civil Aviation Human Factors: An Initiative for Research and Application*:

Human-Centered Automation: This research focuses on the role of the operator and the cognitive and behavioral effects of using automation to assist humans in accomplishing their assigned tasks. The research in this area addresses the identification and application of knowledge concerning the relative strengths and limitations of humans in an automated environment. It investigates the implications of computer-based technology in the design, evaluation, and certification of controls, displays, and advanced systems.

Selection and Training: Research in this area strives to understand the relationship between human abilities and aviation task performance; enhances the measures and methods for the prediction of current and future job/task performance; establishes a scientific basis for the design of training programs, devices, and aids for individuals and teams; defines criteria for assessing future training requirements; and identifies new ways to select aviation system personnel.

Human Performance Assessment: Within this thrust area, research identifies the intrinsic cognitive and decision-making factors for individuals and teams which determine how well they are able to perform aviation tasks; characterizes the impact of environmental and individual factors on human performance; and improves and standardizes methods for measuring human performance.

Information Management and Display: Under this thrust area, research addresses the presentation and transfer of information among components in the NAS. It seeks to identify the most efficient and reliable ways to display and exchange information; determines what, when, and how one might best display and transfer information to system components; designs a system to reduce the frequency of information transfer errors and misinterpretations; and strives to minimize the impact when such errors do occur.

Bioaeronautics: Research in this area involves the bioengineering, biomedicine, and biochemistry associated with performance and safety. The objective is enhancement of personal performance and safety by maximizing crew and passenger protection, health, and physiological integrity. The program consists of three research initiatives: human protection and survival; medical and toxicological factors in accident investigation; and support for aeromedical certification and in-flight aeromedical applications through aviation medicine program support.

Customer and Stakeholder Involvement

The Human Factors program directly supports a range of aviation community initiatives and congressional mandates, including research into the effects of shift work and fatigue (also the distribution of educational materials on fatigue), and the

effects of English language proficiency upon the work of international controllers.

The FAA 2000 Performance Plan has identified areas of human factors research concentration that have led to collaborative efforts between the agency and industry. These include efforts to reduce operational error as a factor in aviation accidents and to integrate human factors into system acquisition.

The Mission Goal for Safety identified in the 1998 FAA Strategic Plan (“by 2007 reduce the U.S. aviation fatal accident rate by 80% from 1996 levels”) has fostered collaboration with the aerospace community in efforts that include: building on currently successful efforts to identify the individual, organizational, and system factors associated with past accidents; using new data sources in a more proactive analytical approach to identifying and reducing key human factors risks; and working with NASA, DOD, and other public and private organizations, in studying issues and technologies with potential to improve policies, procedures, and equipment.

Achievement of the first two goals identified in the Office of the Associate Administrator for Research and Acquisitions Performance Plan has resulted in collaborative research. Goal 1: Contribute to the FAA goal to reduce the fatal aviation accident rate by 80 percent by 2007, as compared to 1996 baseline data. Goal 2: Ensure that policies, processes, and best Human Factor practices are integrated in the research and acquisition of 100 percent of FAA aviation systems and applications.

A wide range of additional collaborative research efforts that have been mandated through many government and private sources have been undertaken through the program. These include:

- Issues addressed by the Runway Safety Program, including memory enhancement techniques, training for tower controllers, pilot/controller communications phraseology, runway markings and lighting, air traffic control teamwork enhancement training, and improved procedures designed to avoid runway incursions.
- Human factors research associated with the Safer Skies program, which employs the latest technology to help analyze U.S. and global data to determine root causes of accidents and identify appropriate actions to break the chain of events that lead to accidents.
- A coherent national agenda to ensure an adequate human factors emphasis in bioaeronautics research and apply resulting insights to making significant improvements in NAS safety and efficiency. These concerns were identified through extensive aviation community participation and were listed in the “National Plan for Civil Aviation Human Factors: An Initiative for Research and Application,” published in March 1995, with FAA, NASA, and DOD as signatories.
- Research into priority issues associated with crew training, the collection and use of safety data, the application of emerging technologies, and aircraft maintenance procedures and inspection as identified in The Aviation Safety Plan.
- The application of insights derived from human factors research in the Implementation of the FAA report on “The Interfaces between Flight Crews and Modern Flight Deck Systems.”
- Public Law 100-591 — establishes requirements for human factors research and its application.
- The FY 1998 Department of Transportation Appropriations Act — cites human factors as the greatest cause of aviation accidents and calls for high priority research.
- The Aviation Safety Research Act of 1988 — requires that human factors research be conducted to “enhance air traffic controller performance, develop a human factors analysis of the hazards associated with new technologies, identify innovative and effective corrective measures for human errors, and develop dynamic simulation models of the ATC system.”
- The RTCA “Free Flight Action Plan” — addresses recommendations to: establish more flexible decision support systems involving Collaborative Decision Making; conduct human-in-the-loop simulations for assessing controller and pilot perceptions of hazards,

risks, and discomfort; measure performance, workload, and situation awareness associated with controller and pilot responses to time and distance; conduct real-time human-in-the-loop simulations to systematically study controller and pilot behaviors, interactions, and effects within NAS environments that represent dynamic densities and sector configurations anticipated for free flight.

- On-site, realistic research made possible through access to the personnel and facilities of airline and aviation maintenance organizations. These organizations have benefited from research products such as electronic job aids, intelligent tutoring systems, guidance on work site environmental conditions, shift-work studies, and advanced training methods.

The Aviation Medicine program also directly supports a number of aviation community initiatives and congressional mandates, including:

- Research in the protection and survival of aircraft occupants; medical accident investigation and airman medical certification; toxicology and the effects of drugs on human performance; and the impact of disease and disability on human performance, as required by Public Law 100-591 [H.R. 486]; November 3, 1988 (known as the Aviation Safety Research Act of 1988).
- Toxicological analyses on specimens from, and special pathologic studies on, aircraft accident fatalities as required by DOT Order 8020.11A, Chapter 4, Paragraph 170.
- Investigations of selected general aviation and air carrier accidents and searches for the biomedical clinical causes of accidents, including evidence of disease and chemical abuse, as required by DOT Order 1100.2C, Chapter 53, Paragraph 53-15.
- State-of-the-art toxicological tests on the blood, urine, and tissue of pilots involved in fatal accidents to determine the levels of both licit and illicit drugs at both the therapeutic and abnormal levels, as requested by National Transportation Safety Board Safety Recommendations A-84-93.
- The Aviation Medicine Program is an integral participant and research provider under the

FAA, Joint Aviation Authorities, and the Transport Canada Aviation Aircraft Cabin Safety Research Plan (established in 1995), which sets forth long-term research goals and ensures coordination between international aviation agencies. Programs within Aviation Medicine that study aircraft cabin environmental quality and the nature and extent of in-flight medical emergencies are a direct result of specific congressional mandates to study these topics.

Accomplishments

Information Management and Display

- Developed human factors guidelines for air carrier use in constructing operating documents.
- Determined the effectiveness of delivering technical information to line aircraft technicians using wireless, portable, pen-based computers.
- Developed a process to improve work documentation in repair stations.
- Completed a human factors audit of the Converging Runway Display Aid (CRDA) installed at St. Louis Airport. CRDA is a decision support tool that helps terminal radar controllers efficiently space aircraft arriving on separate, converging runways.
- Identified the priorities, organization, and sources of information accessed by pilots during various phases of flight.
- Provided recommendations to the Advanced General Aviation Transport Experiment Working Group regarding pilot performance and human factors issues associated with using highway-in-the-sky displays.
- Completed a project to observe en route controllers' utilization of flight progress strips.
- Designed, developed, and administered the FAA employee attitude survey.

Human-Centered Automation

- Completed human factors assessments of advanced controls and displays for Advanced General Aviation Transport Experiment air-

craft. Provided recommendations to guide certification of those devices.

- Directed a large-scale effort to identify and resolve the significant human factors issues inherent in the STARS display.
- Developed a pocket certification guide for human factors evaluation of multifunction displays.

Human Performance and Assessment

- Developed and field tested (with several airlines) a prototype Automated Performance Measurement System (APMS) which allows for gathering and analysis of data from aircraft flight data recorders. This information and analysis capability is utilized by the Flight Operations Quality Assurance program, a joint FAA and airline venture to enhance aviation safety.
- Validated human performance transfer functions for level B full flight simulators.
- Developed the Human Factors Design Guide for system acquisitions by Integrated Product Teams.
- Initiated a process to integrate shift-change error identification and mitigation processes into the aircraft maintenance error-detection and reporting system.
- Developed pilot performance data through flight simulation for use in establishing certification standards for general aviation automation and control systems.
- Developed the Post-Operations Evaluation Tool that has now been deployed nationally as a common framework for assessing coordinated strategic responses to ATM restrictions.
- Initiated collaborative research with EUROCONTROL scientists to develop a harmonized model to investigate human error in air traffic management.
- Completed evaluation of the application of a human factors analysis and classification taxonomy to Part 121/135 air carrier accidents contained in the NTSB database.
- Completed the congressionally-mandated survey of shift work and fatigue in air traffic controllers.

- Completed a report on the allocation of visual attention for air traffic monitoring and avoidance: baseline measures and implication for Free Flight.

- Completed development of a tool to assess controller communication and coordination and evaluated its effectiveness in a field and laboratory study.

Selection and Training

- Developed a model Advanced Qualification Program (AQP) for use by training centers to support regional air carrier participation in AQP, a proficiency-based approach to pilot training.
- Validated use of simulator parameters and flight data for evaluating Advanced Qualification Program effectiveness.
- Developed error mitigation training for cockpit crews.
- Provided Crew Resource Management procedure guidelines for regional airlines.
- Developed preliminary training guidelines for cockpit distractions and interruptions.
- Produced and presented the FAA Human Factors Course to increase understanding of the importance of considering the "human factor" in design/acquisition of FAA systems.
- Produced and distributed a handbook for Advanced Crew Resource Management training.
- Identified and documented the best practices for engine nondestructive training and related inspections.
- Developed an automated system of self instruction for specialized maintenance training.
- Completed evaluation and recommendations for using PC-based aviation training devices in pilot instrument flight training.
- Validated and approved a new computerized test battery for operational use in selecting air traffic controllers.
- Validated the Basic Electronics Screening Tool for operational use in selecting electronics personnel.

- Developed guidance on situation awareness, error mitigation, and teamwork to support the NAS Infrastructure Management Maintenance Concept and its transition to centralized maintenance management.

Bioaeronautics

- Provided aeromedical accident analysis for evaluation and enhancement of medical certification standards.
- Evaluated autopsy and toxicological data from fatal aviation accidents to recommend protective equipment and design practices, and to determine the incidence of licit and illicit drug use.
- Initiated development of an advanced consolidated data base that integrates accident/incident information with medical certification data to establish a methodology for continuous evaluation of airmen medical certification standards.
- Assessed potential for flight attendant reproductive health hazards by integrating flight data, measurements of radiation, and other aircraft cabin environmental parameters and information from epidemiological studies.
- Evaluated applicability of analytical modeling on dispersion and removal of gaseous and aerosol contaminants in different types of aircraft heating, ventilation, and air conditioning systems.
- Updated educational material and improved access to information on potential exposure to air contaminants and other environmental parameters in aircraft.
- Provided assistance in review and updates of bulletins, reports, and regulations on air quality in aircraft cabins.
- Reported on the suitability of component tests for showing regulatory compliance with crashworthiness standards for aircraft.
- Completed evaluation of child restraint systems and initiated proposed regulations for optimum safety.
- Developed fit and comfort standards for aviation oxygen mask systems.

- Assessed operational hazards of in-flight laser exposure.
- Utilized new DNA probes for determining the existence of post-mortem alcohol in accident fatalities.
- Evaluated the success of automatic external defibrillators and in-flight medical kits utilized in commercial aviation.
- Conducted side-facing sofa crash dynamic tests to evaluate neck loads on occupants, inflatable torso restraint systems, and methods to reduce crash-related injuries.

R&D Partnerships

The Human Factors Program is linked to NASA and DOD under the auspices of the *National Plan for Civil Aviation Human Factors: An Initiative for Research and Application*. Specific areas of coordinated program execution with NASA include cockpit automation, crew resource management, team decision making, air-ground shared separation authority, and decision support automation. DOD joint efforts involve fatigue, team performance, and decision-making research. Additionally, the Human Factors Office maintains a membership in the DOD Human Factors Engineering Technical Advisory Group that provides a forum for the coordination of research across a variety of technical areas.

The Human Factors Office participates with The Netherlands National Research Laboratory in flight deck automation and air/ground integration research. The Office maintains an active membership on all Society of Automotive Engineering G-10 Human Factors subcommittees related to ongoing and future research areas to ensure transition of the results to standards and guidelines. The Human Factors Office places grants with universities supporting research on air carrier training, flight deck automation, general aviation, aviation maintenance technician training, and air traffic management. Coordinated research efforts are conducted with NASA Ames in free flight. An Interagency Agreement with the U.S. Navy Air Warfare Center focuses on development of training and performance measurement strategies to enhance teamwork in flight deck crews. Special attention is being paid to training enhancements that develop aviation teamwork skills and

the utility of advanced technologies for delivering team training.

The Human Factors Office participates in collaborative research with EUROCONTROL on the reduction and management of human error in Air Traffic Management, human performance issues in the design of decision support tools, and on developing a human-centered approach to integrating technologies to ensure aircraft separation. An effort is underway with the Joint Aviation Authorities and Transport Canada to identify and coordinate human factors research in areas of joint interest.

The Office of Aviation Medicine collaborates with the National Institute for Occupational Safety and Health on a study addressing the cabin environment and flight attendant and passenger symptomatology and diseases. In addition, a liaison is maintained with the American Society of Heating, Refrigeration, and Air Conditioning Engineers Committee addressing aircraft cabin air quality status and research.

The Office of Aviation Medicine maintains direct cooperative research processes with all the manufacturers responsible for safety products (seats, restraint systems, oxygen masks, evacuation slides, etc.). The Office of Aviation Medicine is also represented on appropriate subgroups of organizations such as the Aerospace Medical Association, the Society of Automotive Engineers, the Civil Aviation Medical Association, and the Professional Aeromedical Transport Association. Appropriate liaison with the military is maintained either through direct project collaboration (e.g., crashworthiness, eye injury from lasers) or through the more global participation in the Tri-Services Aeromedical Research Panel, and the North Atlantic Treaty Organization (NATO) aerospace medical advisory group.

Long-Range View

The FAA has accepted national responsibility to initiate and maintain research and development programs which support modernization, regulation, certification, and NAS issues, and, with equal importance, national responsibility to initiate research which is proactive in identifying emerging safety trends. The Human Factors investment strategy will directly support proactive

research efforts to identify and reduce targeted safety issues.

Research programs will be directed at targets which will have the greatest impact on aviation safety, will be multi-year efforts, and will require stabilized resources to plan, execute, and complete. Successful implementation of research outputs will require full partnerships and close cooperation within FAA organizations and the aviation community.

Research strategies will focus on technology, partnerships, and measurements. For example, methods will be developed to identify interventions to address human performance issues in aviation maintenance and air traffic operations. With regard to partnership strategies, a five-year integrated safety research plan will be developed with NASA, addressing long-range, high pay-off priorities. Measurement strategies will be developed to accurately monitor trends and identify opportunities for research to mitigate risks.

Public and congressional interest in the maintenance of a healthy and comfortable environment for each category of civil aviation's participants is not abating. The five-year interagency agreement between FAA and NIOSH initiated in FY97 addresses infectious disease and other health considerations in the aircraft cabin environment.

The Aviation Medicine program will continue to emphasize the mitigation of accidents, and reduction in the severity of injuries encountered in such precautionary events as evacuation of passengers from an aircraft after recognition of a safety concern by the flight crew. Through this approach, the program will remain a critical component of FAA efforts to meet its safety and survivability goals.

Additionally, in concert with the targets expressed in Challenge 2000 and with FAA's broad commitments to harmonize safety regulations on a global scale, the Aviation Medicine Program will focus its collaborative interactions with domestic and international laboratories to generate research data. This information will be used in the development of internationally harmonized aviation standards and regulations. Aeromedical research will be increasingly necessary to interpret data derived from around the world, and to assess

whether the data are appropriate or require additional investigation prior to use in regulatory or other actions.

A08a Flight-Deck/Maintenance/System Integration Human Factors

GOALS:

Intended Outcomes: The FAA intends to improve air transportation safety by:

- Developing more effective methods for aircrew, inspector, and maintenance technician training.
- Developing improved human-centered flight controls and displays.
- Increasing human factors considerations in the certification of new aircraft and equipment design and modification.
- Improving aircrew, inspector, and maintenance technician task performance.

Agency Outputs: The FAA ensures the safety and efficiency of operator performance through guidelines, handbooks, advisory circulars, rules, and regulations. It provides industry with human performance information and guidance critical to the design, operation, regulation, and certification of equipment, training, and procedures. With this in mind, the Human Factors Program conducts and manages research that provides the technical information necessary to generate these products and services.

Customer/Stakeholder Involvement: The Human Factors Program directly supports a number of aviation community initiatives:

- *FAA Strategic Plan Mission Goal for Safety.* By FY 2007, reduce U.S. aviation fatal accident rates by 80% from 1996 levels.
- ARA FY 2000 Performance Plan: Goal 1. Contribute to the FAA goal to reduce the fatal aviation accident 80% by FY 2007 as compared to 1994 -1995 baseline data.
- The FAA/Industry *Safer Skies* initiative, which will use the latest technology to help analyze U.S. and global data to find the root causes of accidents and determine the best actions to break the chain of events that lead to accidents.
- The *National Plan for Civil Aviation Human Factors: An Initiative for Research and Application*, published in March 1995 with FAA, NASA, and DOD as signatories. This document, which had extensive aviation com-

munity participation in its development, outlines a coherent national agenda for human factors research and application leading to significant improvements in NAS safety and efficiency.

- The FAA report entitled “The Interfaces Between Flight Crews and Modern Flight Deck Systems.”
- Public Law 100-591, which establishes requirements for human factors research and its application.
- The Advanced Qualification Program (AQP), which has been adopted by every major U.S. carrier, incorporating human factors training into pilot qualification and recurrent training programs.
- Crew Resource Management (CRM) training procedures, a variant of which has been adopted by virtually every major domestic air carrier.

Accomplishments: The program output of data packages, models, and regulatory documents includes:

Information Management and Display

- Developed a manual that addresses appropriate human factors considerations in designing flight deck operating documents. This manual has been adopted by International Civil Aviation Organization (ICAO) for distribution to its member states.
- Published the *Aviation Maintenance Human Factors Guide*.
- Developed and implemented the Agency’s first virtual collaborative research team to communicate and disseminate information in real time regardless of distance or other constraints on research team members
- Developed (with industry) the first industry standard and guidance document on implementing an Aviation Maintenance Human Factors Program.
- Developed the Aviation Maintenance Document Design Aid incorporating simplified English and utilizing advanced technology to standardize aviation maintenance documentation.

- Developed guidance and recommendations on human factors best practices in fluorescent penetrant inspection. This project provided a more systematic view of human/system interaction.
- Completed human factors guidelines for assessing advanced general aviation transportation experiment (AGATE) cockpit controls/displays.
- Developed human factors design and evaluation considerations for Electronic Flight Bags, Version 1.0.
- Completed assessment of human factors issues and current knowledge concerning use of head-up displays in air transports.
- Completed Data Link lessons learned compendium for inclusion in RTCA DO-238A, "Human Factors Requirements and Guidance for Controller/Pilot Data Link Communications Systems."

Human-Centered Automation

- Completed human factors Certification Job Aid Version 1.0 for FAR Part 25 flightdeck displays.
- Developed aircraft certification human factors and operations checklist for stand-alone global positioning system receivers.

Human Performance Assessment

- Developed a prototype Automated Performance Measurement System (APMS) that allows air carriers to gather and analyze flight data from aircraft data recorders. This information and analysis capability provides the backbone for the Flight Operations Quality Assurance Program (FOQA), a joint FAA, industry and labor initiative to enhance aviation safety.
- Provided industry and FAA with preliminary reports on the antecedents of flightdeck error.
- Validated human performance transfer functions for full flight simulators.
- Completed the Job Task Analysis of the Aviation Maintenance Technician Workforce.
- Developed guidance and standardized shift turn over procedures for use in aviation maintenance.

- Developed pilot performance profile, through flight simulation, for use in establishing certification standards for General Aviation auto-navigation and control systems.

Selection and Training

- Developed and validated a proceduralized pilot CRM training and assessment system.
- Developed the Model AQP to support regional air carrier participation. AQP is a proficiency-based approach to pilot training that is considered to be highly effective and efficient for aircrew training.
- Developed air carrier training data analysis tools used by carriers and the FAA for quality assurance efforts.
- Provided Flight Standards guidance for developing pilot training regulations based on data from a study of 40,000 domestic air carrier pilots. The study examined pilots' perceptions of training effectiveness across the entire U.S. aviation industry.
- Developed Line Audit Methodology used by air carriers to help determine safety vulnerabilities. This methodology has been adopted by ICAO and was distributed to member states.
- Provided industry and FAA with preliminary guidelines on training for flight deck interruptions and for the performance of concurrent critical tasks.
- Provided industry and FAA with training guidelines for pilot decision making, addressing first officer's hesitancy to challenge the captain in potentially high risk situations.
- Developed a system to allow air carriers to reconfigure FAA approved flight scenarios to unique training segments and developed a generic line oriented evaluation event set database to be used by any air carrier.
- Incorporated air carrier and FAA user comments into an enhanced reconfigurable event set scenario development system.
- Through innovative training schedules, provided FAA and Industry preliminary guidelines on managing pilot skill degradation.
- Provided Industry and FAA preliminary training guidelines for automated flight decks.

- Provided FAA and Industry guidance on approaches to incorporating realistic radio communications into simulators to train pilots for the complex operating environment.
- Developed the Maintenance Resource Management (MRM) handbook for use by industry.
- Completed the prototype MRM distance learning project that will be implemented and used by the U.S. Navy for training their Naval Aviation Maintenance Technicians. Further application can be applied to U.S. Coast Guard Aviation Maintenance Technicians.
- Developed an Advisory Circular on Training, Qualification, and Certification on Nondestructive Inspection Personnel.
- Developed a prototype automated system of self instruction for specialized training for the industry aviation maintenance inspector workforce.
- Developed a CD-ROM training program that guides General Aviation pilots through the creation of a personal checklist that incorporates minimum operating conditions and procedures based upon their own personal capabilities and experience.
- Developed a CD-ROM training program that describes the structured decision-making style of experienced General Aviation pilots compared to less experienced pilots. The program stresses situational awareness, diagnosis, resolution, and vigilance.
- Developed a CD-ROM training program that teaches General Aviation pilots to recognize the cues associated with deteriorating weather while in-flight, and to take appropriate action to avoid weather.

R&D Partnerships: Collaboration has continued between the FAA and industry partners to develop intervention strategies and reduce aviation accidents through the various Joint Safety Awareness Teams (JSAT) developed as part of the Safer Skies agenda. The human factors program is linked to NASA and DOD under the auspices of the *National Plan for Civil Aviation Human Factors: An Initiative for Research and Application*. Specific areas of coordinated program execution with NASA

include cockpit automation, CRM, team decision making, air-ground communication, and aviation maintenance. DOD joint efforts are in team performance, decision making, aviation MRM, distance learning, and human error risk analysis. Additionally, the FAA is represented on the DOD Human Factors Engineering Technical Advisory Group, a forum for the coordination of research across a variety of technical areas.

Through aviation maintenance partnerships with industry, the FAA and industry are receiving real world applied research results. Aviation maintenance human factors is also working with other countries (such as Transport Canada) for globalization of aviation maintenance and inspection human factors. The FAA participates on all of the Society of Automotive Engineers G-10 human factors subcommittees related to human factors research areas, ensuring transition of the results to standards, guidelines, etc. The FAA also has extended seventeen grants to universities supporting research on air carrier training, flight deck automation, aviation accident analysis, general aviation, and aviation maintenance technician and inspector training.

MAJOR ACTIVITIES AND ANTICIPATED FY 2001 ACCOMPLISHMENTS:

Information Management and Display

- Completed software tools for enhanced maintenance documentation.
- Developed human factors design and evaluation considerations for Electronic Flight Bags, Version 2.0.
- Developed general aviation “head up” display information/symbology recommendations.
- Addressed human factors issues for Cockpit Head Motion Box associated with air transport head-up displays.

Human-centered Automation

- Provided industry and FAA guidance addressing training for automated cockpits. These guidelines will encompass the performance difficulties associated with increased coupling, complexity, and autonomy of modern cockpit technology.

- Completed human factors Certification Job Aid Version 2.0 for FAR Part 25 flightdeck displays.

Human Performance Assessment

- Provided expanded Automated Performance Measurement System (APMS) methodologies and analysis capabilities in order that air carriers can collect and analyze increasing amounts of flight and simulator data.
- Developed mapping of flight data parameters onto AQP qualification standards.
- Completed assessment of the utility of PC-based aviation training devices in maintaining General Aviation pilot instrument proficiency.
- Completed a comprehensive human factors analysis of scheduled air carrier and general aviation fatal accidents using the human factors analysis and classification system (HFACS).
- Identified human factors trends in aviation accident/incident data to produce data driven research initiatives.

Selection and Training

- Developed methods to incorporate automation-specific training scenarios into the system that reconfigures event sets for unique training sessions.
- Validated simulator motion training requirements.
- Developed advanced data analysis methods for linking FOQA and simulator training data.
- Refined and validated training guidelines and training schedules for degradation vulnerable flight tasks.
- Refined training guidelines for automated flight decks.
- Expanded Realistic Radio Communications in simulator training to include data link and other forms of nonverbal communication.
- Analyzed data from line observations and laboratory studies to provide training guidance on human error management.

KEY FY 2002 PRODUCTS AND MILESTONES:

Information Management and Display

- Develop and implement guidelines for maintenance error investigating and reporting systems.
- Develop flight data recording and analysis capability for flight simulators.
- Complete human factors design and evaluation considerations for Electronic Flight Bags, Version 3.0.
- For general aviation aircraft, conduct comparative analyses to determine if any substantial degradation in visual search is concurrent with the presence and/or use of the “head up” or “head down” display, and which tasks benefit most from each type of presentation.
- Complete initial computational model to assess information accessibility for air transport head-up display/head-down display combinations.
- Determine operational criteria and training guidance for night vision goggles in rotorcraft operations.
- Determine type of information to be presented to develop adequate situational awareness required to avert Controlled Flight Into Terrain (CFIT) in general aviation.
- Define display location boundaries that correspond to established eye position/head position for general aviation aircraft during actual operations.

Human-centered Automation

- Provide industry and the FAA expanded guidance addressing training for automated cockpits. These guidelines will encompass the performance difficulties associated with increased coupling, complexity, and autonomy of modern cockpit technology.
- Develop certification guidelines for integrated technology in general aviation cockpits.
- Complete human factors Certification Job Aid, version 3.0 for FAR Part 25 flightdeck displays.

Human Performance Assessment

- Refine flight and simulator data analysis tools.
- Provide guidance on the effectiveness of realistic radio communications in line oriented evaluations.
- Define general aviation pilot decision-making skills required for training module development.
- Provide expanded APMS methodologies and analysis capabilities in order that air carriers can collect and analyze increasing amounts of flight and simulator data.
- Develop improved human factors guidelines for aircraft accident investigation and reporting systems.
- Examine simultaneous non-interfering operations for visual flight rules (VFR) helicopter and fixed wing visual flight rules/instrument flight rules (VFR/IFR) to determine human performance implications.

Selection and Training

- Provide guidance to FAA Flight Standards for training regulations on simulator motion requirements for recurrent pilot training.
- Validate training guidelines for seldom practiced flight tasks.

- Develop training guidelines for flight deck error management.
- Distribute advanced analysis methods linking FOQA and simulator data.
- Develop materials to increase general aviation pilot skills to intervene in the causable chain of events leading to accidents.
- Develop proactive error avoidance and prevention strategies to reduce negative responses by aviation maintenance and inspection personnel whether by commission, omission, inadequate training, or timing.
- Demonstrate and validate the effectiveness of the MRM change program.
- Determine the application of military aviation maintenance training and experience based on FAA requirements.

FY 2002 PROGRAM REQUEST:

The program continues to focus on providing technical information and consultation to improve aircrew, inspector, maintenance technician, and aviation system performance. Emphasis is on developing guidelines, tools, and training to enhance error capturing and mitigation capabilities in the flight deck and maintenance environments; and on developing human factors tools to ensure that human performance considerations are adequately addressed in the design and certification of flight decks and equipment.

APPROPRIATION SUMMARY

	Amount (\$000)
Appropriated (FY 1982-2000)	\$ 137,980
FY 2001 Enacted	10,078
FY 2002 Request	9,906
Out-Year Planning Levels (FY 2003-2006)	42,067
Total	\$ 200,031

Budget Authority (\$000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Contracts:					
Flightdeck/Maint/System Integration Human Factors	10,365	8,497	6,289	7,016	6,617
Personnel Costs	1,814	1,940	2,367	2,283	2,398
Other In-house Costs	371	563	486	779	891
Total	12,550	11,000	9,142	10,078	9,906

OMB Circular A-11, Research and Development (\$000)	Conduct of	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Basic		0	0	0	0	0
Applied		12,550	11,000	9,142	10,078	9,906
Development (includes prototypes)		0	0	0	0	0
Total		12,550	11,000	9,142	10,078	9,906

2001 FAA NATIONAL AVIATION RESEARCH PLAN

A08a - Flight-Deck/Maintenance/System Integration Human Factors Product and Activities	FY 2002 Request (\$000)	Program Schedule					
		FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY2006
081-110 Flightdeck/Maintenance/System Integration Human Factors							
Selection and Training	\$2,654						
Develop Automation Reconfigurable Event Sets		◆	◇	◇			
Provide Guidance for Simulator Motion Requirements		◆	◇	◇	◇		
Develop/Distribute Advanced Data Analysis Methods Linking FOQA and Simulator Data		◆	◇	◇	◇		
Develop Training Guidelines for Flight Deck Error Management		◆	◇	◇	◇		
Develop Materials to Increase General Aviation Pilot Skills to Intervene in Accident Chain to Events		◆	◇	◇	◇	◇	◇
Develop Error Avoidance Strategies in Aviation Maintenance and Inspection		◆	◇	◇	◇	◇	◇
Demonstrate and Validate Effectiveness of MRM		◆	◇	◇	◇		
Human Performance Assessment	\$450						
Provide Expanded APMS Methodologies and Analysis Capabilities		◆	◇	◇	◇	◇	◇
Provide Guidance on Effectiveness of Realistic Radio Communications in Line-Oriented Evaluations		◆	◇				
Develop Improved Guidelines for Accident Investigations		◆	◇	◇			
Human Centered Automation	\$1,806						
Provide Industry and FAA Guidance Addressing Training for Automated Cockpits		◆	◇	◇			
Complete Certification Job Aid Version 2.0/3.0 for FAR Part 25 Flight Deck Displays		◆	◇	◇	◇		
Develop Certification Guidelines for Integrated Technology in General Aviation Cockpits		◆	◇	◇			
Information Management and Display	\$1,707						
Complete Software Tools for Enhanced Maintenance Documentation		◆	◇				
Complete Human Factors Design and Evaluation for Electronic Flight Bags, Version 2.0/3.0		◆	◇	◇			
Develop/Analyze General Aviation "head-up" Display Information/Symbology Recommendations		◆	◇	◇			
Address Human Factors Issues in Cockpit Head Motion Box in Air Transport "head-up" Displays; Complete Computational Model to Assess Information Accessibility		◆	◇	◇	◇	◇	
Determine Operational Criteria/Training Guidance for Night Vision Goggles in Rotorcraft Operations		◆	◇	◇			
Determine Information Requirements in Situational Awareness to Avert CFIT in General Aviation		◆	◇	◇	◇		
Define Display Location Boundaries that Correspond to Eye/Head Position for General Aviation Aircraft		◆	◇	◇			
Personnel and Other In-House Costs	\$3,289						
Total Budget Authority	\$9,906	\$10,078	\$9,906	\$10,146	\$10,376	\$10,656	\$10,889

Note: Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.

A08b Air Traffic Control/Airway Facilities Human Factors**GOALS:**

Intended Outcomes: The FAA intends to improve air traffic control safety by:

- Developing more effective methods for investigating, reporting, and analyzing operational errors and deviations.
- Developing human factors educational aids to mitigate runway incursions and underlying human performance issues.
- Developing human factors educational aids to mitigate controller fatigue resulting from shiftwork.
- Increasing human factors considerations in the acquisition and design of air traffic control automation systems.
- Improving techniques for identifying workforce requirements and selecting applicants for Air Traffic and Airway Facilities positions.

Agency Outputs: Human factors problems in today's operations involve human performance constraints and other complications that pose risk to the acquisition of Air Traffic Control (ATC) systems. The study of the relationship between shiftwork schedules and fatigue is identifying techniques for mitigating impacts on controller performance. Taxonomic analysis of operational errors is identifying improvements in how errors are investigated and reported, which in turn is leading to more effective safety interventions. Human factors research provides guidelines and other information for the design and development of ATC systems and product improvements. Tests and criteria for the selection of operational personnel improve applicant screening efficiency and validity.

Customer/Stakeholder Involvement: The ATC/Airways Facilities (AF) Human Factors Research Program Research Program is directly tied to the following ARA Safety Performance Goals:

Goal 1. *Aviation Safety:* Contribute to the FAA goal of reducing the fatal aviation accident rate 80% by FY 2007 as compared to 1994-1996 baseline data.

Goal 2. *Human Factors:* In support of FAA's performance goals, ARA will, by FY 2005, ensure human factors policies, processes, and best practices are integrated in the research and acquisition of 100 percent of FAA aviation systems and applications. Two implementation strategies entail research on NAS integration and human error that contribute to acquisition programs and acquisition activities associated with the analysis, design, development, testing, deployment, and implementation of FAA systems and applications.

The ATC/AF Human Factors Research Program is the product of continued cooperation and collaboration between the Office of the Chief Scientific and Technical Advisor for Human Factors (AAR-100) and its customer base, the Air Traffic Requirements Service (ARS). The detailed research portfolio is coordinated with several organizational elements:

- Plans and Performance Directorate (ARX-20)
- Resource Management Program (AFZ-100)
- NAS Operations (AOP-30)
- Air Traffic Procedures (ATP-400)
- The Air Traffic Services Office of Evaluations and Investigations (AAT-20)

In addition, Integrated Product Teams in the Office of Communication, Navigation, and Surveillance Systems (AND), and the Office of Air Traffic Systems Development (AUA) share in identifying research requirements through AAR-100 representatives. Projects are coordinated with the Office of System Architecture and Investment Analysis (ASD-130).

Human Factors research is grounded in addressing issues that emerge from the FAA's Operations Concept for 2005. The program draws on the NAS Architecture Version 4.0 call for "a broad range of research activities regarding the implications of human factors." Research activities will develop the information necessary to understand human capabilities and limitations in each functional area. Human factors engineering will then be applied to identify and resolve risks, and to assess costs, benefits, and trade-offs.

The ATC/AF Human Factors Research Program is responsive to the recommendations of the congressionally-mandated Research, Engineering, and Development Advisory Committee (REDAC). The REDAC has recommended that the program concentrate its efforts on “broader, more fundamental issues: effects of stress with increased workload; introducing new systems in the heavily-loaded ATC environment; sharing responsibility between controller and pilot; and the human as a monitor of highly-automated systems.”

Central to this research program is the joint FAA, NASA, and DOD *National Plan for Civil Aviation Human Factors: An Initiative for Research and Application*, published in 1995. This document outlines a coherent national agenda for human factors research and application leading to significant improvements in NAS safety and efficiency. Human factors research is organized around the following four thrusts:

- *Information Management and Display* - Determine what, when, and how one might best display and transfer information to system components; design the system to reduce the frequency of information transfer errors; and minimize the impact when such errors do occur.
- *Human-Centered Automation* - Keep the operator in-the-loop and situationally aware of automated system performance while balancing operator workload; resolve issues related to the degradation of basic skills should the automation fail.
- *Human Performance Assessment* - Identify the intrinsic characteristics of individuals and teams that determine how well they are able to perform tasks; characterize the impact of environmental and individual factors on human performance; and improve and standardize methods for measuring human performance.
- *Selection and Training* - Assess the knowledge and skills needed to excel in highly automated environments, including impacts of new technology.

Accomplishments: The program has supported the following research with resulting products:

Information Management and Display

- Standard Terminal Automation Replacement System (STARS) - Conducted comprehensive assessment of the STARS operational radar display and maintenance control workstations. A related initiative yielded a definitive process to integrate human factors in other NAS acquisitions.
- Guidelines on use of Color in ATC Displays – Provided Integrated Product Teams (IPT) reference guidance on the most effective uses for color coding operational information in new system displays.

Human-Centered Automation

- Flight Strip Studies – Identified operational functions in controller use of paper flight progress strips to support transition to Free Flight Phase I decision-support automation.
- Auditory Alarm Database – Developed database of alarms for use in the design of future AF alerting systems for centralized maintenance centers.

Human Performance and Assessment

- Air Traffic Control Specialist (ATCS) Shift Work Schedules – Completed first element of congressionally-mandated study through a survey addressing controller shiftwork, fatigue, and performance.
- Runway Incursion Human Factors Workshop – Completed workshop involving government, industry, and academic perspectives leading to the definition of research needs addressing performance risks and airport complexity factors.
- Flight Service Station Operational and Supportability Implementation System (OASIS) Study – Conducted virtual reality ergonomic evaluation of proposed workstations.
- Impact of Shared Separation on ATCS Situation Awareness – Conducted study of impacts from distributed air/ground separation responsibility on air traffic controller performance.
- Human factors booklet for controllers. This brochure provides controllers with helpful in-

formation about human factors they can use to enhance job performance.

- Report on the impact of airspace restructuring on air traffic controller performance.

Selection and Training

- Variable Item Generator (VIGOR) for Personnel Selection – Prototyped proof-of-concept computer tool to generate knowledge test items for screening applicants for Airway Facilities positions.
- Basic Electronic Screening Tool (BEST) – Developed screening test for selection of AF new hires, with an estimated savings of \$3-5 million/year in reduced training costs.

R&D Partnerships: Coordinated research is conducted with NASA Ames in the areas of distributed air/ground separation responsibility and human error, and with the Naval Research Laboratory regarding enhanced vision technology for towers. Internationally, part of the joint FAA-EUROCONTROL Action Plan 12 for the management and reduction of human error involves harmonizing research methods for operational errors.

MAJOR ACTIVITIES AND ANTICIPATED FY 2001 ACCOMPLISHMENTS:

Information Management and Display

- Human Factors Design Guide (HFDG) – Update of the HFDG provides Integrated Product Teams with guidelines for effective human factors design of automation and communication/navigation/surveillance technologies.
- Computer-Human Interface (CHI) Integration – Report for Integrated Product Teams on identified CHI inconsistencies between designs of legacy systems and anticipated product improvements and other subsystems to be integrated as part of NAS evolution.
- AF Visual Symbolology – Report to AOP on human factors design guidance and CHI inconsistencies in the NAS Infrastructure Management System (NIMS).

Human-centered Automation

- Flight Strip Replacement – Assess controller operational requirements in use of paper

flight progress strips in en route and approach transitions in support of Free Flight Phase 1 decision-support automation.

- Enhanced Vision Systems – Demonstration of enhanced vision technology under reduced visibility conditions to support tower controller information requirements.

Human Performance and Assessment

- Controller Alternative Work Schedules – Complete the second element of the Congressionally mandated study through field biomedical studies of controller work schedules and rest cycles.
- Runway Safety Booklet – Booklet of informative human factors information for controllers and pilots to help prevent runway incursions addressing communications, attention and memory, and threats to performance.
- Display System Replacement (DSR) Comparison - Report on comparison of task load and performance measures for pre- and post-DSR implementation.
- Sector Team Communications - Baseline assessment of sector team communication and controller coordination from transition to conflict probe.

Selection and Training

- Prototype Air Traffic Applicant Screening System – Development of a prototype biographical assessment tool for screening job applicants.
- Validation of Airway Facilities BEST – Completion of a formal BEST validation relative to available criteria to screen job applicants. The resulting screening tool could save \$3-5 million/year in reduced training costs.

KEY FY 2002 PRODUCTS AND MILESTONES:

ATS-related research within the National Plan research thrusts include:

Information Management and Display

- CHI Integration – Detailed assessments of CHI inconsistencies between designs of en route and oceanic legacy systems and anticipated product improvements and other subsystems to ensure compatibility with design

guidelines and human performance considerations.

- Information management in AF systems - Assessment for improving information transfer and display to support system specialist and team performance in the AF environment.

Human-centered Automation

- Reduction in use of paper flight progress strips - Refinements to automation, procedures and training to facilitate reducing the operational need for paper flight progress strips will be developed.
- Situational awareness in centralized monitor and control - Determine what information and feedback is necessary for AF System Specialists to stay aware of automated processes in relation to workload, performance, and error mitigation.

Human Performance and Assessment

- Examination of causal factors related to operational errors - This project is targeted at reducing operational errors and deviations through the understanding and mitigation of causal factors.
- ATC sector teamwork and Collaborative Decision Making (CDM) - Assess how enhanced decision support and automated coordination tools affect intra- and inter-sector communications and coordination.
- Shift work and fatigue - This research will assess the fatigue countermeasure recommendations developed by the Scientific Steering

Group as based on findings from the congressionally-mandated research on shift patterns.

- POWER task load and performance baseline assessments – Assess the utility of POWER's objective metrics to define and assess expert controller performance with baseline systems.
- Team processes in centralized monitor and control systems - Develop team and organizational guidelines to enhance effective team operations.
- Organizational assessment - Assess human factors issues and successful organizational practices in developing a Model Work Environment.

Selection and Training

- Develop and validate computerized application evaluation systems – Develop new, make technical enhancements, and continue longitudinal validation of screening and text tools for selection of applicants into ATC, En Route Traffic (ET), and Air Traffic Services (ATS) positions.
- Develop a prototype workforce analysis tool - This application will support the identification and analysis of gaps between current and future workforce skills and staffing profiles.

FY 2002 PROGRAM REQUEST

The FY 2002 program supports ATS with research to address human performance over the next several years. Research projects will focus on providing timely information to answer critical human factors questions.

APPROPRIATION SUMMARY

	Amount (\$000)
Appropriated (FY 1982-2000)	\$ 100,785
FY 2001 Enacted	7,982
FY 2002 Request	9,900
Out-Year Planning Levels (FY 2003-2006)	42,836
Total	\$ 161,503

Budget Authority (\$000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Contracts:					
Air Traffic Control/Airway Facilities Human Factors	5,454	5,711	1,661	2,277	4,156
Personnel Costs	3,773	3,117	5,034	3,984	4,071
Other In-house Costs	773	1,172	1,305	1,721	1,673
Total	10,000	10,000	8,000	7,982	9,900

OMB Circular A-11, Research and Development (\$000)	Conduct of	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Basic		0	0	0	0	0
Applied		10,000	10,000	8,000	7,982	9,900
Development (includes prototypes)		0	0	0		0
Total		10,000	10,000	8,000	7,982	9,900

2001 FAA NATIONAL AVIATION RESEARCH PLAN

A08b - Air Traffic Control/Airway Facilities Human Factors Product and Activities	FY 2002 Request (\$000)	Program Schedule					
		FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY2006
082-110 Air Traffic Control/Airway Facilities Human Factors							
Human Performance Assessment	\$895						
Examination of Causal Factors Related to Operational Errors		◆	◇	◇	◇	◇	◇
Runway Safety Analysis and Guidance/Booklet		◆		◇			
Sector Team Communications		◆	◇	◇			
ATC Sector Teamwork and Communications		◆	◇	◇	◇	◇	◇
Controller Shift Work, Work Schedules, and Fatigue		◆	◇	◇			
POWER Task Load and Performance Assessment of the Display		◆	◇	◇			
System Replacement							
Team Processes in Centralized Monitor and Control Systems		◆	◇	◇	◇	◇	◇
Organizational Assessment		◆	◇	◇	◇	◇	◇
Integrate Human Performance Modeling		◆	◇	◇	◇	◇	◇
Human Centered Automation	\$1,463						
Flight Strip Replacement and Electronic Flight Data		◆	◇	◇	◇	◇	◇
Enhanced Vision Systems		◆	◇				
Situational Awareness in Centralized Monitor and Control		◆	◇	◇	◇	◇	◇
Controller Decision Making		◆	◇	◇			
Information Management and Display	\$1,298						
Human Factors Design Guidance		◆	◇	◇	◇	◇	◇
Computer-Human Interface Integration		◆	◇	◇	◇		
AF Information Display and Management		◆	◇	◇	◇	◇	◇
Selection and Training	\$500						
Prototype Air Traffic Applicant Screening System		◆	◇	◇			
Validation of AF Basic Electronics Screening Tool		◆	◇	◇			
Develop and Validate Computerized Application Evaluation Systems		◆	◇	◇	◇	◇	◇
Prototype Workforce Analysis Tool Development and Analysis		◆	◇	◇	◇	◇	◇
<i>Personnel and Other In-House Costs</i>	\$5,744						
Total Budget Authority	\$9,900	\$7,982	\$9,900	\$10,213	\$10,528	\$10,882	\$11,214

Note: Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.

A08c Aeromedical Research

GOALS:

The FAA safety mission dictates that:

- Injury and death patterns in civilian flight accidents be investigated and meticulously analyzed to determine cause and prevention strategies.
- Recommendations for protective equipment and procedures be developed.
- Options be evaluated on behalf of FAA regulatory and medical certification staff charged with the proposal of safety and health regulations addressing all aircraft cabin occupants.
- Pilot, flight attendant, and passenger medical conditions be identified that are incompatible with in-flight physiological and performance demands – these conditions could exist either in the absence or the presence of emergency flight conditions. The resulting bioaeronautical data is to be effectively shared using advanced, user-friendly modeling and visualization technologies.

Intended Outcomes: The outcomes addressed by this research program are improved health, safety, protection, and survivability of aircraft passengers and aircrews. This research program identifies human tolerances, capabilities, and failure modes (physiological, psychological, and performance) both in uneventful flight, and during aircraft incidents and accidents. Formal recommendations for protective and supportive counter-measures and techniques are derived from in-house research.

The FAA is able to exploit new and evaluate existing bioaeronautical guidelines, standards, and models for aircraft cabin equipment, procedures, and environments. This work serves as a base for new regulatory action and the evaluation of existing regulations to enhance appropriate human performance at a minimum cost to the aviation industry. By reviewing pilot medical histories, flight histories along with information from accidents and incidents, existing and advanced biomedical criteria, standards and assessment/ certification procedures can be proposed to ensure optimal performance capability. By assessing pilot, flight attendant, air

traffic controller, and passenger work, environmental, behavioral, and disease issues, guidelines for actions to improve the health and safety of the aircraft occupant can be proposed based on rigorous scientific criteria.

Agency Outputs: The program has developed the following guiding principles to support regulatory and certification processes:

- Quantitative bioengineering criteria to support optimum aircraft seat and restraint system certification.
- Quantitative biomedical and performance criteria to support protective breathing equipment, emergency medical equipment, and operational procedures certification.
- Quantitative bioaeronautical criteria to support flotation and onboard life support/rescue equipment certification.
- Quantitative biomedical and performance criteria to support development of optimum protective breathing equipment, emergency medical equipment, and operational procedures certification.
- Identification of biomedical/toxicological factors in aviation incidents and accidents.
- Recommendations for aircrew medical criteria, standards, assessment/certification procedures, and special issuance.
- Quantitative data about the occupational health risks of flight attendants to support regulatory oversight.
- Quantitative data about passenger behavior and health to support regulatory oversight.
- Quantitative data about the aerospace radiation environment and its threats to aircraft occupants.

Customer/Stakeholder Involvement: This program contributes to meeting the FAA Strategic Plan Mission Goal for Safety and ARA FY 2000 Performance Plan Goals for Safety and Human Factors. The program provides the primary bioaeronautical research called for in the *National Plan for Civil Aviation Human Factors*. [Note: The subject of this research is defined as the bioengineering, biomedicine, and biochemistry issues associated with safety and performance.]

This program contributes significantly to the application of emerging technologies, as highlighted in the FAA Aviation Safety Plan. The program is an integral participant and research provider under the FAA, Joint Aviation Authorities (JAA), and Transport Canada Aviation (TCA) Aircraft Cabin Safety Research Plan that was established in 1995 as a coordinated, living plan to maximize the cost-benefit of aircraft cabin safety research internationally.

International Civil Aviation Organization (ICAO) initiatives addressing the health of the aircraft occupant (crew and passenger) are developed under this program before final FAA recommendations are provided to ICAO. This program is the only research component of the FAA that can legally access confidential medical data about pilots for use in epidemiological research studies approved by FAA's institutional review board for use of human test subjects. Multi-year collaborative studies performed by the FAA and National Institute for Occupational Safety and Health (NIOSH) into flight attendant and passenger symptomatology and diseases are funded by this budget item to satisfy the mandate placed by Congress upon the agencies in the FY 1994 Appropriation Act.

Accomplishments: Based on aeromedical research at the Civil Aeromedical Institute (CAMI), the FAA Administrator announced in FY 2000 the Agency's intention to proceed with regulations for the requirements concerning the performance and use of child restraints in aircraft. Standards and test criteria developed at CAMI are currently being considered for adoption by the Society of Automotive Engineers (SAE). Specialized quantitative crashworthiness assessments for aircraft continued, inclusive of side-facing aircraft seats, and included the use of new state-of-the-art anthropomorphic test dummies with enhanced injury assessment capabilities.

Data are continuously provided to the research sponsor on the role of toxicological and clinical factors associated with each aircraft accident and significant incident. Current findings indicate that about one of six pilots fatally injured in a civilian aircraft accident shows evidence of using a prescription drug; one of four has taken an over-the-counter drug; one of 25 has ingested signifi-

cant positive alcohol; and 1 of 20 is using a significant controlled dangerous substance. Long-term aviation forensic and epidemiological research has helped the FAA to identify bioaeronautical roles in accident/incident causation. Specialized clinical evaluations have been applied to cases associated with aircraft decompression. Medical and other factors indicative of pilot incapacitation and inability to perform optimally are under continuous evaluation. To promote radiation safety in civil aviation, instructional materials on radiation exposures in-flight were provided to the aviation industry.

R&D Partnerships: In addition to the previously described partnerships (e.g., FAA/JAA/TCA; FAA/NIOSH), academic, industrial, and other governmental coordination and cooperation are maximally leveraged in all research activities. In each of the program area output categories, the FAA maintains direct cooperative research processes with all the manufacturers responsible for the safety products enumerated (seats, restraint systems, oxygen masks, evacuation slides, etc.). FAA investigators also maintain memberships on every Society of Automotive Engineers committee addressing safety research conducted under this program. The agency maintains a liaison with the American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) committee addressing aircraft cabin air quality status and research. Besides the active involvement in the FAA/JAA/TCA process of oversight for safety research, participants in this program are represented on appropriate subgroups of organizations such as the Aerospace Medical Association, the Civil Aviation Medical Association, and the Professional Aeromedical Transport Association. Appropriate liaison is maintained with the all military branches either through direct project collaboration (e.g., crashworthiness, aerospace medicine, eye injury from lasers, exposure to cosmic radiation), through participation in the North Atlantic Treaty Organization aerospace medical advisory groups, the European Union, or collaborations in scientific organizations.

MAJOR ACTIVITIES AND ANTICIPATED FY 2001 ACCOMPLISHMENTS

The following program results have been achieved or are expected to be achieved in FY 2001:

- Performed epidemiological assessment of biochemical and toxicological factors from fatal civilian aviation accidents.
- Assessed the results of automatic external defibrillators on commercial aircraft.
- Evaluated autopsy data from fatal aviation accidents to determine protective equipment and design practices.
- Assessed flight attendant reproductive health hazards (Congressionally requested FAA-NIOSH study).
- Identified key factors affecting safety associated with child restraints in aircraft.
- Developed a performance-based standard for Crew Protective Breathing And Vision Equipment (CPBVE).
- Proposed changes to regulations for operational aviation hazards of laser exposure to humans.

KEY FY 2002 PRODUCTS AND MILESTONES

- The following program results are being scheduled in FY 2002:
- Develop medical data that will support aeromedical certification aimed at reducing in-flight sudden/subtle incapacitation.
- Evaluate autopsy data from fatal aviation accidents to determine protective equipment and design practices and aircrew medical certification standards.
- Provide guidelines for aircraft cabin occupant health maintenance, including verifying the CARI-6 radiobiologic computer program that covers large solar particle events.
- Assess optimum wide-body exit distribution and access using the 747 evacuation simulator (if simulator construction is completed.)
- Develop improved fit and comfort standards for oxygen mask systems.

- Evaluate pilot reported medication usage with actual toxicology findings to determine the accuracy of self reporting.
- Evaluate the safety record of pilots with a Statement Of Demonstrated Ability (SODA) in support of aeromedical certification standards.

FY 2002 PROGRAM REQUEST:

The Office of Aviation Medicine encounters complex medical decisions during the initial and follow-up medical assessments of airmen who request special medical issuances (e.g., cardiac conditions, neurological deficits, etc.) to permit their continued flying. The prospective epidemiological assessment of special issuance methodology and medical outcomes in the airman population is required to ensure that medical issuances do not result in unexpected or increased aircraft accident or incident rates or risks.

Ongoing research projects will:

- Support safer aircraft cabin evacuation approval guidelines and safer field applications under routine and emergency operational conditions.
- Reduce head, neck, torso, and extremity injuries in aircraft crash environments.
- Evaluate trends in toxicological, biochemical, physiological, and clinical findings from all major civil aviation aircraft crashes.
- Assess guidelines for aircraft cabin crew and passenger environmental management.
- Assess performance of new cabin aisle marking systems for use during emergencies.
- Assess effectiveness of new programs dedicated to the enhancement of passenger performance in emergencies.
- Evaluate the use of Automatic External Defibrillators (AED) and make rulemaking recommendations.
- Evaluate in-flight use of medical kits and determine the adequacy of those kits.
- Track special medical issuance pilots to evaluate relative risk and the continuance of specific aeromedical certification standards.
- Provide recommendations for limits to radiation exposure (laser and ionizing).

2001 FAA NATIONAL AVIATION RESEARCH PLAN

- Develop an advanced aeromedical research accident database that is user friendly, has rapid response, and produces advanced statistical and graphics analysis.
- Develop dynamic modeling capabilities in support of cabin safety research, biodynamic protection/ survivability research and aircraft accident investigation research.

APPROPRIATION SUMMARY

	Amount (\$000)
Appropriated (FY 1982-2000)	\$ 71,616
FY 2001 Enacted	5,987
FY 2002 Request	6,121
Out-Year Planning Levels (FY 2003-2006)	27,161
Total	\$ 110,885

Budget Authority (\$000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Contracts:					
Aeromedical Research	0	313	394	938	491
Personnel Costs	3,320	3,155	3,858	3,893	4,268
Other In-house Costs	680	597	577	1,156	1,362
Total	4,000	4,065	4,829	5,987	6,121

OMB Circular A-11, of Research and Development (\$000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Basic	0	0	0	0	0
Applied	4,000	4,065	4,829	5,987	6,121
Development (includes prototypes)	0	0	0	0	0
Total	4,000	4,065	4,829	5,987	6,121

2001 FAA NATIONAL AVIATION RESEARCH PLAN

A08c - Aeromedical Research Product and Activities	FY 2002 Request (\$000)	Program Schedule					
		FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY2006
086-110 Aeromedical Research							
Cabin Health and Environmental Guidelines	\$0						
Assessed of Aircrew Health Risks During a Flying Career		◆	◇	◇	◇	◇	◇
Model of Disease Transmission in Aircraft Cabins			◇	◇	◇		
Human Protection/Survival in Civil Aviation	\$175						
Analyze the Suitability for Component Tests as an Alternative for Showing Regulatory Compliance with Crashworthiness Standard for Aircraft		◆	◇	◇	◇	◇	◇
Assess Impact Protection Performance of Aircraft Seating Systems, Including Child Restraints		◆	◇	◇	◇		
Develop Performance-Based Narrow and Wide Bodied Aircraft Cabin Evacuation Approval Guidelines		◆	◇	◇	◇	◇	◇
Report on Suitability of Aircraft Cabin Evacuation Modeling as a Partial Replacement for Evacuation Tests with Human Subjects		◆	◇	◇	◇	◇	
Development of Improved Oxygen Mask Fit, Comfort, and Performance Standards		◆	◇	◇	◇	◇	
Analyzed the Influence of Cabin Crew Duty Stations on Evacuation Performance of Passenger Aircraft in Panic Situations		◆	◇	◇			
Develop Dynamic Modeling Capabilities in Support of Cabin Safety, Protection, and Aircraft Accident Research			◇	◇	◇	◇	◇
Medical/Toxicology Factors of Accident Investigations	\$316						
Perform Epidemiological Assessment of Toxicology Factors from Fatal Civilian Aviation Accidents		◆	◇	◇	◇	◇	◇
Develop Guidelines to Reduce In-Flight Sudden/Subtle Incapacitation		◆	◇	◇	◇		
Evaluate Autopsy Data from Fatal Aviation Accidents to Determine Protective Equipment and Design Practices		◆	◇	◇	◇	◇	◇
Develop Biochemical Tests to Distinguish between Ingested and Post-Mortem Alcohol		◆	◇	◇	◇		
Develop Instructional Material on the Radiation (Cosmic and Visual) Environment during Air Travel		◆	◇	◇	◇	◇	◇
Survey of In-Flight Medical Emergencies and Defibrillator Usage on Commercial Airline Flights		◆	◇	◇	◇		
Determine an Advanced Aeromedical Accident Research Database			◇	◇	◇	◇	◇
Personnel and Other In-House Costs	\$5,630						
Total Budget Authority	\$6,121	\$5,987	\$6,121	\$6,378	\$6,644	\$6,925	\$7,214

Note: Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.

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